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Intelsat¹

IMPACT OF LOSS OF SYNCHRONIZATION ON GSO TRANSMISSIONS

1 INTRODUCTION

1. This contribution analyzes the impact of the potential loss of synchronization caused by NGSO interference into INTELSAT digital transmissions, as well as the impact of NGSO interference on the occurrence of frozen frames in MPEG-2 TV video signals.
2. The document presents the results of laboratory tests conducted on an IF to IF loop to determine, for different durations of interference pulses, the C/(N+I) values that would cause loss of synchronization for modems operating at various data rates and coding schemes and, for MPEG-2 DVB decoders operating at two different data rates, the C/(N+I) values that would cause frozen frames on the video signal.
3. The measurements also determined the time it took for the digital modems and DVB decoders to recover synchronization once the interference level ceased to be excessive.
4. It has already been pointed out during the previous JTG 4-9-11 meetings that the total outage time of a service affected by loss of synchronization is larger than the outage of the modems themselves due to the time to recover communication at higher protocol layers. Except for the MPEG-2 DVB decoders, this document does not attempt to quantify total downtime for the possible applications running on the modems.
5. Once the levels of interference that cause loss of synchronization and the associated recovery times were determined, the INTELSAT carriers which had their link budgets provided to the ITU were analyzed to determine how they would be impacted. For this purpose, the model proposed in document JTG 4-9-11/311 to estimate the mean time between NGSO interference events was expanded to include estimates of total yearly modem/DVB decoder outage times.
6. The document concludes that, if the current levels of downlink EPFD limits for 100% of the time contained in Article S.22 of the Radio Regulations for NGSO systems are maintained, in particular for Ku-band, loss of synchronization events will contribute significantly to degrade the performance of GSO digital transmissions beyond the target values specified in Recommendation

¹ This document contains the results of studies conducted within INTELSAT and has been written in consultation with the Advisory Committee on Technical Matters of the INTELSAT Board of Governors, to be submitted to WP 4A to contribute to the on-going consideration of the matters therein.

ITU-R S.1323. However, no frozen frame events are expected for MPEG-2 DVB transmissions under the current EPFD limits.

7. This contribution does not propose specific 100% of the time EPFD limits to replace those contained in Article S.22 of the Radio Regulations because of unavailability of information on recovery time of applications running on digital carriers, the need to extend the assumptions used for the FSS earth station location and antenna pointing, and because the limits are somewhat NGSO systems dependent. However, a methodology for derivation of the required limits is suggested, and could be used once consensus is reached on the above points.

2 LOSS OF SYNCHRONIZATION MEASUREMENTS

8. Using the set-up indicated in Figure 1, INTELSAT conducted a series of laboratory measurements to determine, for different interfering pulse durations, the C/N+I values that would cause digital demodulators to loose synchronization, and the total time that they would remain on that state (outage time), including the time to recover synchronization once the excess interference ceased (recovery time).

9. Similarly, using the setup indicated in Figure 2, the C/N+I values that would cause frozen frames to appear in MPEG-2 video signals received through DVB decoders were calculated. Additionally, the total outage time for the DVB decoder suffering loss of synchronization due to interference was also determined.

10. The following Tables provide the results obtained:

TABLE 1
64 kbit/s QPSK, Rate 3/4 FEC

| Interference Duration (sec) | IF C/N+I Loss of Synchronization Threshold (dB) | Total Outage Time (sec) | Recovery Time (sec) |
|-----------------------------|---|-------------------------|---------------------|
| 0.5 | 3.4 | 9.1 | 8.6 |
| 1.0 | 3.8 | 20.8 | 19.8 |
| 2.0 | 4.2 | 21.5 | 19.5 |
| 3.0 | 4.2 | 20.3 | 17.3 |
| 4.0 | 4.2 | 20.4 | 16.4 |

TABLE 2
2 Mbit/s QPSK, Rate 3/4 FEC

| Interference Duration (sec) | IF C/N+I Loss of Synchronization Threshold (dB) | Total Outage Time (sec) | Recovery Time (sec) |
|-----------------------------|---|-------------------------|---------------------|
| 0.5 | 3.1 | 3.6 | 3.1 |
| 1.0 | 3.2 | 3.8 | 2.8 |
| 2.0 | 3.2 | 3.9 | 1.9 |
| 4.0 | 3.2 | 6.1 | 2.1 |

TABLE 3
8 Mbit/s QPSK, Rate 3/4 FEC

| Interference Duration (sec) | IF C/N+I Loss of Synchronization Threshold (dB) | Total Outage Time (sec) | Recovery Time (sec) |
|-----------------------------|---|-------------------------|---------------------|
| 0.5 | 3.9 | 9.8 | 9.3 |
| 1.0 | 3.9 | 9.7 | 8.7 |
| 2.0 | 3.9 | 10.7 | 8.7 |
| 4.0 | 3.9 | 10.3 | 6.3 |

TABLE 4
34 Mbit/s QPSK, Rate 3/4 FEC

| Interference Duration (sec) | IF C/N+I Loss of Synchronization Threshold (dB) | Total Outage Time (sec) | Recovery Time (sec) |
|-----------------------------|---|-------------------------|---------------------|
| 0.5 | 4.1 | 2.8 | 2.3 |
| 1.0 | 4.2 | 2.8 | 1.8 |
| 2.0 | 4.3 | 3.8 | 1.8 |
| 3.0 | 4.4 | N/A* | - |
| 4.0 | 4.5 | N/A | - |

Note: N/A*: Value not available.

TABLE 5
64 kbit/s QPSK, Rate 1/2 FEC

| Interference Duration (sec) | IF C/N+I Loss of Synchronization Threshold (dB) | Total Outage Time (sec) | Recovery Time (sec) |
|-----------------------------|---|-------------------------|---------------------|
| 0.5 | 1.7 | 9.5 | 9.0 |
| 1.0 | 2.3 | 20.3 | 19.3 |
| 2.0 | 2.7 | 21.9 | 19.9 |
| 3.0 | 3.0 | 20.7 | 17.7 |
| 4.0 | 3.1 | 21.1 | 17.1 |

TABLE 6
2 Mbit/s QPSK, Rate 1/2 FEC

| Interference Duration (sec) | IF C/N+I Loss of Synchronization Threshold (dB) | Total Outage Time (sec) | Recovery Time (sec) |
|-----------------------------|---|-------------------------|---------------------|
| 0.5 | 3.4 | 3.6 | 3.1 |
| 1.0 | 3.6 | 4.0 | 3.0 |
| 2.0 | 3.5 | 3.7 | 1.7 |
| 3.0 | 3.6 | 6.1 | 3.1 |
| 4.0 | 3.6 | 8.5 | 4.5 |

TABLE 7
2 Mbit/s 8PSK, Rate 2/3 FEC with 201/219 Reed Solomon Outer Coding

| Interference Duration (sec) | IF C/N+I Loss of Synchronization Threshold (dB) | Total Outage Time (sec) | Recovery Time (sec) |
|-----------------------------|---|-------------------------|---------------------|
| 0.5 | 7.9 | 3.6 | 3.1 |
| 1.0 | 7.9 | 3.6 | 2.6 |
| 2.0 | 7.9 | N/A | - |
| 3.0 | 7.9 | N/A | - |
| 4.0 | 7.9 | N/A | - |

TABLE 8

8 Mbit/s 8PSK, Rate 2/3 FEC with 201/219 Reed Solomon Outer Coding

| Interference Duration (sec) | IF C/N+I Loss of Synchronization Threshold (dB) | Total Outage Time (sec) | Recovery Time (sec) |
|-----------------------------|---|-------------------------|---------------------|
| 0.5 | 7.7 | 9.6 | 9.1 |
| 1.0 | 7.6 | 10.1 | 9.1 |
| 2.0 | 7.6 | N/A | - |
| 3.0 | 7.6 | N/A | - |
| 4.0 | 7.8 | N/A | - |

TABLE 9

34 Mbit/s 8PSK, Rate 2/3 FEC with 201/219 Reed Solomon Outer Coding

| Interference Duration (sec) | IF C/N+I Loss of Synchronization Threshold (dB) | Total Outage Time (sec) | Recovery Time (sec) |
|-----------------------------|---|-------------------------|---------------------|
| 0.5 | 7.8 | 2.2 | 1.7 |
| 1.0 | 7.8 | 5.0 | 4.0 |
| 2.0 | 7.9 | N/A | - |
| 3.0 | 7.9 | N/A | - |
| 4.0 | 7.8 | 7.9 | 3.9 |

TABLE 10

8 Mbit/s DVB QPSK, Rate 3/4 FEC with 204/188 Reed Solomon Outer Coding

| Interference Duration (sec) | IF C/N+I Freeze Frame Threshold (dB) | Total Outage Time for Loss of Sync (sec) | Recovery Time (sec) |
|-----------------------------|--------------------------------------|--|---------------------|
| 0.5 | 5.4 | 5.6 | 5.1 |
| 1.0 | 5.4 | 5.0 | 4.0 |
| 2.0 | 5.4 | 6.2 | 4.2 |
| 4.0 | 5.4 | 8.9 | 4.9 |

TABLE 11

34 Mbit/s DVB QPSK, Rate 3/4 FEC with 204/188 Reed Solomon Outer Coding

| Interference Duration (sec) | IF C/N+I Freeze Frame Threshold (dB) | Total Outage Time for Loss of Sync (sec) | Recovery Time (sec) |
|-----------------------------|--------------------------------------|--|---------------------|
| 0.5 | 4.5 | 2.1 | 1.6 |
| 1.0 | 4.5 | 2.8 | 1.8 |
| 2.0 | 4.5 | 3.7 | 1.7 |
| 4.0 | 4.6 | 6.3 | 2.3 |

11. These results are in line with previous results reported in other JTG 4-9-11 contributions. Taking into account a 0.5 dB degradation due to the non-linearity of the satellite transponder, they suggest the use of the C/N+I synch loss thresholds of 5 dB for Rate 3/4 carriers, 4.1 dB for Rate 1/2 carriers, 8.4 dB for 8PSK Rate 2/3 carriers and 5.9 dB for MPEG-2 DVB decoder freeze frame thresholds.

12. Additionally, it can be concluded that, for the 2 Mbit/s INTELSAT IDR carrier, the average recovery time of the modem itself is anywhere between 2 and 3 seconds. In other words, each time there is a loss of synchronization event, the modem will be ineffective for the duration of the interference event added to the recovery time.

13. For the particular modem used for the 8 Mbit/s measurements, which is one of the most widely used for that range of data rates, the recovery time is about 9 seconds. This is due to the fact that, although clock and carrier recovery takes about half the time taken by the 2 Mbit/s modem, demux synchronization, which is based on a sequential search algorithm, takes four times longer than for the 2 Mbit/s modem.

14. The recovery time for the 34 Mbit/s modem is between 2 and 4 seconds. This modem employs a different, quicker demux synchronization algorithm with respect to the 8 Mbit/s modem.

3 OUTAGE DUE TO LOSS OF SYNCHRONIZATION

15. Document JTG 4-9-11/331 proposed a method to provide an indication of the mean time between losses of synchronization likely to be experienced by digital demodulators in an earth station of a GSO network due to downlink interference from a non-GSO FSS system. The model used assumed an earth station at the equator with 90° elevation angle and provided, as a function of receive earth station antenna diameter and the difference in dB between the downlink EPFD value adopted for 100% of the time and the actual EPFD that causes loss of synchronization, the desired results for a number of interfering non-GSO systems at Ku and Ka band.

16. Based on the same assumptions, the time during which the interference will be higher than the value that actually causes loss of synchronization can be estimated, and given the average time interval between such events, so can the total outage time due to loss of synchronization.

17. Assuming the EPFD value remains constant during the interference event, the duration of the event defined as "interference greater than the threshold value that causes loss of

"synchronization" is the time during which the interfering non-GSO satellite is within the area in which the receive GSO FSS earth station antenna gain is too high to attenuate the interfering signal below loss of synchronization level.

18. Using the equations provided in document JTG 4-9-11/331, the attenuation S below peak gain of the receive GSO FSS earth station antenna required to avoid loss of synchronization is determined from the off-axis angle ϕ by the following expression:

$$S = 12 (\phi/\phi_0)^2 \text{ dB} \quad (1)$$

where ϕ_0 is the half power beamwidth of the receive GSO FSS earth station antenna in degrees and the approximation holds for S up to 15.3 dB.

19. Given ϕ and the geometry assumed in document JTG 4-9-11/331, there is a corresponding value of θ which is the angle of the cone defined by the center of the Earth and the intersection of the vertical cone of angle ϕ and vertex at the receive GSO FSS earth station, with the sphere where the interfering non-GSO satellites are orbiting (see Figure 3).

20. The average angle γ relative to the center of the earth, which defines the angular portion of the trajectory of the interfering non-GSO satellite within the area that causes loss of synchronization, can be determined from the spherical triangle OAGF in Figure 3 in accordance with the following expression:

$$\cos \theta = \cos \delta \cos \gamma/2 + \cos 90^\circ \sin \delta \sin \gamma/2 \quad (2)$$

or

$$\gamma = 2 \text{ arc cos } (\cos \theta / \cos \delta) \quad (3)$$

where δ is a random variable which assumes values from $-\theta$ to $+\theta$ with equal probability.

21. The expected value of γ can then be derived as:

$$E\{\gamma\} = \int_{-\theta}^{\theta} 2 * \text{arccos}(\cos \theta / \cos \delta) * (1/2\theta) d\delta \quad (4)$$

22. The average duration of the event defined as "interference greater than the threshold value that causes loss of synchronization" is then determined by the time the interfering non-GSO satellite will take to travel the angle $E\{\gamma\}$, which is simply $V_R E\{\gamma\}$, where V_R is the angular velocity of the NGSO satellite relative to that of the GSO earth station.

23. The expression for $E\{\gamma\}$ can be approximated by the result obtained by assuming that the intersection of the cone with vertex in the center of the Earth and angle θ with the sphere of orbit of the interfering non-GSO satellites is flat, in which case the value of $E\{\gamma\}$ is $(\theta\pi)/2$.

24. Based on the method provided in document JTG 4-9-11/331, the average expected duration of each interference event for four non-GSO systems operating in Ku-band and four non-GSO systems operating in Ka-band was calculated in Table 15 for various GSO FSS antenna diameters and values of S, using the approximate expression for $E\{\gamma\}$. The total average duration of the

events defined as "interference greater than the threshold value that causes loss of synchronization" in any year is the sum of the contributions from each non-GSO systems operating in the same frequency bands. The contribution of each system is the average duration of each event multiplied by the average number of events in any year, which can be determined from the mean time between sync losses (MTBS) derived with the equations provided in document JTG 4-9-11/331.

25. Table 15 calculates the total average duration of events for each individual interfering NGSO system considered and the combined effect assuming that all of them are implemented.

26. It should be noted that the total outage of a circuit affected by loss of synchronization is the sum of three components:

- a) the duration of the interference event as define above;
- b) the recovery time of the modem; and
- c) the recovery time of the upper layers of the protocol used for the particular application.

27. Based on the above methodology, the combined interference of the four NGSO systems considered in the Ku and Ka bands were analyzed for the larger antenna diameters used with the INTELSAT link budgets provided to the JTG 4-9-11. Assuming the combined interference of four NGSO systems, the total yearly time in which the NGSO interference exceeds the level that causes loss of synchronization and the total yearly number of such events can be calculated for the various receive earth station antenna diameters as a function of the "shortfall", defined as the difference between the 100% EPFD limit and the EPFD level that causes loss of synchronization.

28. The results obtained can be expressed in the following form:

(i) For Ku-band:

the total number of combined interference events per year (E) is equal to

$$E = 127.97 \times \frac{10}{\phi} \times \sqrt{S} \quad (5)$$

and

the total combined shortfall duration (D) per year in seconds is equal to

$$D = 76.83 \times \left(\frac{10}{\phi} \right)^2 \times S \quad (6)$$

where ϕ is the earth station receive antenna in m and S is the shortfall in dB.

(ii) For Ka-band:

the total number of combined interference events (E) per year is equal to

$$E = 150.34 \times \frac{5}{\phi} \times \sqrt{S} \quad (7)$$

and

the total combined shortfall duration per year (D) in seconds is equal to

$$D = 172.36 \times \left(\frac{5}{\phi} \right)^2 \times S \quad (8)$$

with ϕ and S as above.

29. The total outage time (T_{LS}) in seconds resulting from such events is approximately equal to the sum of the duration of the events (D) plus the total number of events (E) multiplied by the average recovery time (R) of the application running on the affected modems:

$$T_{LS} = D + (E \times R) \quad (9)$$

The unavailability due to loss of synchronization alone (U_{LS}) can be determined in percentage as:

$$U_{LS} = \left(\frac{T_{LS}}{N_s} \right) \times 100 \quad (10)$$

where N_s is the total number of seconds in a year.

4 SHORTFALL FOR INTELSAT CARRIERS

30. Given the proposed 100% of the time APFD and EPFD limits for Ku and Ka bands, an analysis was conducted to determine whether there would be any shortfall for the INTELSAT carriers for which link budgets have been provided to the JTG 4-9-11. The results are provided in Tables 16 to 29.

31. From the results of Tables 16 to 29, it can be verified that, if the current 100% of the time EPFD limits are maintained, the following outage times due to loss of synchronization alone would occur if 4 co-frequency NGSO systems were to be implemented in each band under consideration:

TABLE 12
Ku-Band IDR Results
(0.004% Unavailability Allowance to NGSO)

| Antenna Diameter (m) | Maximum Shortfall (dB) | Number of Events/Year | Total Outage Time Per Year (sec) | Synch Loss Unavailability (%) |
|----------------------|------------------------|-----------------------|----------------------------------|-------------------------------|
| 10.0 | 9.7 | 398.56 | 1940.93 | 0.0062 |
| 8.0 | 8.2 | 458.06 | 2358.57 | 0.0075 |
| 2.4 | 0.4 | 337.23 | 1545.23 | 0.0049 |

For the above table, R was assumed to be the average recovery time of the modems only, with a value of 3 seconds.

TABLE 13

Ku-Band IBS Results**(0.04% Unavailability Allowance to NGSO)**

| Antenna Diameter (m) | Maximum Shortfall (dB) | Number of Events/Year | Total Outage Time Per Year (sec) | Synch Loss Unavailability (%) |
|----------------------|------------------------|-----------------------|----------------------------------|-------------------------------|
| 10.0 | 10.9 | 422.49 | 2104.93 | 0.0067 |
| 8.0 | 9.5 | 493.04 | 2619.56 | 0.0083 |
| 2.4 | 1.8 | 715.37 | 4547.06 | 0.0144 |

For the above table, R was assumed to be the average recovery time of the modems only, with a value of 3 seconds.

TABLE 14

Ka-Band Results**(0.05% Unavailability Allowance to NGSO)**

| Antenna Diameter (m) | Maximum Shortfall (dB) | Number of Events/Year | Total Outage Time Per Year (sec) | Synch Loss Unavailability (%) |
|----------------------|------------------------|-----------------------|----------------------------------|-------------------------------|
| 5.0 | 15.1 | 584.20 | 4355.24 | 0.0138 |
| 3.5 | 12.0 | 743.99 | 6453.03 | 0.0204 |
| 2.4 | 8.7 | 923.83 | 9279.88 | 0.0294 |
| 1.8 | 6.2 | 1039.84 | 11365.15 | 0.0360 |
| 1.2 | 2.8 | 1048.20 | 11523.20 | 0.0365 |

For the above table, R was assumed to be the average recovery time of the modems only, with a value of 3 seconds.

32. For the MPEG-2 DVB transmissions, on the other hand, the current EPFD limits provisionally contained in Article S.22 of the Radio Regulations ensure sufficient protection of INTELSAT carriers against frozen frames of errors on the video signal.

33. The values of outage due to loss of synchronization caused by NGSO interference indicated in Tables 12 to 14 are shown to be sometimes larger than the total unavailability time allocated to the aggregate NGSO interference.

34. It should be noted that the unavailability time allocated to the aggregate NGSO interference is the total time the GSO link will operate below the corresponding availability threshold, which is higher than the loss of synchronization threshold. It should be expected, therefore, that the outage time due to loss of synchronization should be a fraction of the total unavailability time allocated to the aggregate NGSO interference.

35. In fact, the total outage due to loss of synchronization should be equal to the difference between the total unavailability time allocated to the aggregate NGSO interference and the total time in which the GSO link will be operating between the availability threshold and the loss of synchronization threshold.

36. The above criterion could then be used to determine the allowed 100% EPFD limit, by using the following steps:

- a) Determine the total unavailability time T_T (each year) allocated to the aggregate NGSO interference (10% of the time the GSO circuit can operate below threshold);
- b) Determine the total time T_{TH} (each year) the GSO link will be operating between the availability threshold and the loss of synchronization threshold;
- c) Determine the total outage time T_{LS} allocated to loss of synchronization as the difference between the above two values:

$$T_{LS} = T_T - T_{TH} \quad (11)$$

- d) Using equations (5) through (9), determine the shortfalls allowed; and
- e) Using the link budgets of the GSO carriers, determine the allowed 100% EPFD limits.

5 CONCLUSIONS

37. Based on the above results it can be concluded that, if the current 100% EPFD limit contained in Article S.22 of the Radio Regulations are not tightened, in particular for Ku-band NGSO systems, the out of synchronization events can cause outages in excess of the total allowance for unavailability due to the combined effect of NGSO interference. It is therefore imperative to tighten these limits.

38. The specific 100% of the time EPFD limits to replace those contained in Article S.22 of the Radio Regulations will depend on information on recovery time of applications running on digital carriers, the knowledge of how the assumptions used for the FSS earth station location and antenna pointing can be extended to more general cases, and the assumptions used for the interfering NGSO systems. However, a methodology for derivation of the required limits is suggested, and could be used once consensus is reached on the above points.

TABLE 15
Estimation of Loss of Synchronization Events

| Frequency (GHz) | 11 | 11 | 11 | 11 | Total Ku | 19 | 19 | 19 | 19 | Total Ka |
|-----------------------------|-----------------|-----------------|-----------------|-----------------|----------|-----------------|-----------------|-----------------|-----------------|----------|
| NGSO Constellation Type | Skybridge | Rostelsat | H-NET | USA Ku-M1 | | CONTAC T | Celestri | Skybridge-II | LM-MEO | |
| No of Satellites (n) | 80 | 91 | 70 | 16 | | 16 | 63 | 96 | 32 | |
| Height (km) | 1470 | 700 | 1490 | 20181 | | 10400 | 1400 | 1468 | 10352 | |
| Inclination (°) | 53 | 82 | 54.5 | 53 | | 45 | 48 | 55 | 50 | |
| GSO E/S Antenna Dia (m) | 10.8 | 10.8 | 10.8 | 10.8 | | 5 | 5 | 5 | 5 | |
| Synch Loss Shortfall (dB) | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | |
| Half-power beamwidth (rad) | 0.003085 | 0.003085 | 0.003085 | 0.003085 | | 0.003858 | 0.003858 | 0.003858 | 0.003858 | |
| Phi (rad) | 0.000892 | 0.000892 | 0.000892 | 0.000892 | | 0.001115 | 0.001115 | 0.001115 | 0.001115 | |
| Theta (rad) | 0.000167 | 0.000088 | 0.000169 | 0.000678 | | 0.000691 | 0.000201 | 0.000209 | 0.000690 | |
| V (°/min) | 3.114220 | 3.636136 | 3.102351 | 0.500096 | | 0.996068 | 3.156367 | 3.115412 | 1.000359 | |
| Relative V (°/min) | 2.970485 | 3.609842 | 2.964171 | 0.402633 | | 0.838147 | 2.994853 | 2.979065 | 0.861225 | |
| Gamma (rad) | 0.067265 | 0.068635 | 0.068717 | 0.518852 | | 0.212510 | 0.062075 | 0.068797 | 0.224246 | |
| Beta (rad) | 0.004971 | 0.002572 | 0.004919 | 0.002733 | | 0.006555 | 0.006472 | 0.006071 | 0.006206 | |
| MTBL (days) | 7.900313 | 13.421304 | 9.122931 | 71.851771 | | 29.956366 | 7.705034 | 5.390309 | 15.819614 | |
| Mean arc (rad) | 0.0002624 | 0.0001386 | 0.0002653 | 0.0010643 | | 0.0010858 | 0.0003153 | 0.0003278 | 0.0010839 | |
| Mean duration (sec) | 0.29 | 0.13 | 0.29 | 7.32 | | 3.75 | 0.34 | 0.36 | 3.72 | |
| Average Number of Events | 46.20 | 27.20 | 40.01 | 5.08 | | 12.18 | 47.37 | 67.71 | 23.07 | |
| Total outage per year (sec) | 13.38 | 3.56 | 11.76 | 37.17 | | 45.66 | 16.27 | 24.49 | 85.94 | |
| Total number of events/year | | | | | 118.49 | | | | | 150.34 |
| Combined outage (sec) | | | | | 65.87 | | | | | 172.36 |

Table 15 (Cont.)

| Frequency (GHz) | 11 | 11 | 11 | 11 | Total Ku | 19 | 19 | 19 | 19 | Total Ka |
|-----------------------------|-----------|-----------|-----------|-----------|----------|-----------|-----------|--------------|-----------|----------|
| NGSO Constellation Type | Skybridge | Rostelsat | H-NET | USA Ku-M1 | | CONTAC-T | Celestri | Skybridge-II | LM-MEO | |
| No of Satellites (n) | 80 | 91 | 70 | 16 | | 16 | 63 | 96 | 32 | |
| Height (km) | 1470 | 700 | 1490 | 20181 | | 10400 | 1400 | 1468 | 10352 | |
| Inclination (°) | 53 | 82 | 55 | 53 | | 84.7 | 48 | 55 | 50 | |
| GSO E/S Antenna Dia (m) | 10.8 | 10.8 | 10.8 | 10.8 | | 5 | 5 | 5 | 5 | |
| Synch Loss Shortfall (dB) | 2 | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | |
| Half-power beamwidth (rad) | 0.003085 | 0.003085 | 0.003085 | 0.003085 | | 0.003858 | 0.003858 | 0.003858 | 0.003858 | |
| Phi (rad) | 0.001261 | 0.001261 | 0.001261 | 0.001261 | | 0.001577 | 0.001577 | 0.001577 | 0.001577 | |
| Theta (rad) | 0.000236 | 0.000125 | 0.000239 | 0.000958 | | 0.000978 | 0.000284 | 0.000295 | 0.000976 | |
| V (°/min) | 3.114220 | 3.636136 | 3.102351 | 0.500096 | | 0.996068 | 3.156367 | 3.115412 | 1.000359 | |
| Relative V (°/min) | 2.970485 | 3.609842 | 2.966035 | 0.402633 | | 1.004316 | 2.994853 | 2.979065 | 0.861225 | |
| Gamma (rad) | 0.067265 | 0.068635 | 0.069099 | 0.518852 | | 0.250472 | 0.062075 | 0.068797 | 0.224246 | |
| Beta (rad) | 0.007030 | 0.003638 | 0.006919 | 0.003865 | | 0.007888 | 0.009153 | 0.008586 | 0.008776 | |
| MTBL (days) | 5.586358 | 9.490291 | 6.486707 | 50.806861 | | 24.892988 | 5.448270 | 3.811517 | 11.186138 | |
| Mean arc (rad) | 0.0003711 | 0.0001959 | 0.0003752 | 0.0015051 | | 0.0015355 | 0.0004459 | 0.0004635 | 0.0015328 | |
| Mean duration (sec) | 0.41 | 0.19 | 0.42 | 10.35 | | 5.30 | 0.49 | 0.51 | 5.27 | |
| Average Number of Events | 65.34 | 38.46 | 56.27 | 7.18 | | 14.66 | 66.99 | 95.76 | 32.63 | |
| Total outage per year (sec) | 26.77 | 7.12 | 23.39 | 74.33 | | 77.71 | 32.54 | 48.98 | 171.88 | |
| Total number of events/year | | | | | 167.25 | | | | | 210.05 |
| Combined outage (sec) | | | | | 131.61 | | | | | 331.10 |

Table 15 (Cont.)

| Frequency (GHz) | 11 | 11 | 11 | 11 | Total Ku | 19 | 19 | 19 | Total Ka |
|-------------------------------|-----------|-----------|-----------|-----------|----------|-----------|-----------|--------------|-----------|
| NGSO Constellation Type | Skybridge | Rostelsat | H-NET | USA Ku-M1 | | CONTAC T | Celestri | Skybridge-II | LM-MEO |
| No of Satellites (n) | 80 | 91 | 70 | 16 | | 16 | 63 | 96 | 32 |
| Height (km) | 1470 | 700 | 1490 | 20181 | | 10400 | 1400 | 1468 | 10352 |
| Inclination ($^{\circ}$) | 53 | 82 | 55 | 53 | | 84.7 | 48 | 55 | 50 |
| GSO E/S Antenna Dia (m) | 10.8 | 10.8 | 10.8 | 10.8 | | 5 | 5 | 5 | 5 |
| Synch Loss Shortfall (dB) | 3 | 3 | 3 | 3 | | 3 | 3 | 3 | 3 |
| Half-power beamwidth (rad) | 0.003085 | 0.003085 | 0.003085 | 0.003085 | | 0.003858 | 0.003858 | 0.003858 | 0.003858 |
| Phi (rad) | 0.001544 | 0.001544 | 0.001544 | 0.001544 | | 0.001931 | 0.001931 | 0.001931 | 0.001931 |
| Theta (rad) | 0.000289 | 0.000153 | 0.000293 | 0.001174 | | 0.001197 | 0.000348 | 0.000361 | 0.001195 |
| V ($^{\circ}/min$) | 3.114220 | 3.636136 | 3.102351 | 0.500096 | | 0.996068 | 3.156367 | 3.115412 | 1.000359 |
| Relative V ($^{\circ}/min$) | 2.970485 | 3.609842 | 2.966035 | 0.402633 | | 1.004316 | 2.994853 | 2.979065 | 0.861225 |
| Gamma (rad) | 0.067265 | 0.068635 | 0.069099 | 0.518852 | | 0.250472 | 0.062075 | 0.068797 | 0.224246 |
| Beta (rad) | 0.008610 | 0.004455 | 0.008474 | 0.004733 | | 0.009661 | 0.011210 | 0.010515 | 0.010749 |
| MTBL (days) | 4.561236 | 7.748786 | 5.296368 | 41.483617 | | 20.325012 | 4.448485 | 3.112085 | 9.133429 |
| Mean arc (rad) | 0.0004545 | 0.0002400 | 0.0004595 | 0.0018434 | | 0.0018806 | 0.0005462 | 0.0005677 | 0.0018773 |
| Mean duration (sec) | 0.50 | 0.23 | 0.51 | 12.67 | | 6.49 | 0.59 | 0.63 | 6.45 |
| Average Number of Events | 80.02 | 47.10 | 68.92 | 8.80 | | 17.96 | 82.05 | 117.28 | 39.96 |
| Total outage per year (sec) | 40.15 | 10.69 | 35.09 | 111.50 | | 116.56 | 48.81 | 73.48 | 257.82 |
| Total number of events/year | | | | | 204.84 | | | | 257.26 |
| Combined outage (sec) | | | | | 197.42 | | | | 496.66 |

TABLE 16: KU-BAND CARRIERS

| Carrier | | IDRX10 | IDRX11 | IDRX12 | IDR110 | IDR111 | IDR112 | IBS-10 | IBS-11 | IBS-12 | 8PSK-10 | 8PSK-11 | 8PSK-12 |
|---------------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Modulation | | QPSK |
| Coding | | FEC 3/4 | FEC 1/2 | FEC 1/2 | FEC 1/2 | FEC 2/3 | FEC 2/3 | FEC 2/3 |
| Information Rate | kbit/s | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 2048 | 2048 | 2048 |
| Transmission Rate | kbit/s | 85 | 85 | 85 | 85 | 85 | 85 | 140 | 140 | 140 | 3504 | 3504 | 3504 |
| Noise Bandwidth | kHz | 51.2 | 51.2 | 51.2 | 51.2 | 51.2 | 51.2 | 83.7 | 83.7 | 83.7 | 1168 | 1168 | 1168 |
| Clear Sky C/N+I | dB | 10.0 | 10.0 | 10.0 | 10.2 | 11.4 | 11.6 | 5.8 | 5.3 | 5.5 | 11.5 | 12.6 | 13.0 |
| Uplink Frequency | GHz | 6.0 | 6.0 | 6.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| Uplink APFD | dBW/(m ² /4kHz) | N/A | N/A | N/A | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 |
| Uplink e.i.r.p. | dBW | 47.5 | 47.8 | 47.7 | 43.6 | 45.3 | 45.4 | 39.8 | 39.4 | 39.6 | 58.6 | 60.1 | 60.6 |
| Uplink Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Atmospheric Absorption | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Transmit Elevation Angle | degrees | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 |
| Uplink Path Length | km | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | dB | N/A | N/A | N/A | 33.1 | 34.5 | 34.7 | 27.2 | 26.4 | 26.7 | 34.6 | 35.7 | 36.3 |
| Resulting Clear Sky C/N+I | dB | 10 | 10 | 10 | 10.2 | 11.4 | 11.6 | 5.8 | 5.3 | 5.5 | 11.5 | 12.6 | 13.0 |
| Downlink Frequency | GHz | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 |
| Receive Gain of 1m ² | dBi | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 |
| Receive Antenna Diam. | m | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Receive Antenna Gain | dBi | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 |
| Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Receiver Elevation Angle | degrees | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 |
| Downlink Path Length | km | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37077 | 38625 | 38293 | 37074 | 38625 | 38293 |
| Downlink Path Loss | dB | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 |
| Atmospheric Absorption | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 4.1 | 4.1 | 4.1 | 8.4 | 8.4 | 8.4 |
| Synch Loss C/I | dB | 6.7 | 6.7 | 6.7 | 6.6 | 6.1 | 6.1 | 9.0 | 10.3 | 9.7 | 11.3 | 10.5 | 10.2 |
| Downlink e.i.r.p. | dBW | 3.8 | 3.8 | 3.8 | 2.9 | 4.2 | 4.4 | 6.0 | 6.3 | 6.5 | 17.8 | 19.1 | 19.6 |
| Power at Antenna Output | dBW | -142.49 | -142.85 | -142.77 | -143.39 | -142.45 | -142.17 | -140.29 | -140.35 | -140.07 | -128.49 | -127.55 | -127.07 |
| Synch Loss Interfering Power | dBW | -149.14 | -149.50 | -149.43 | -149.95 | -148.57 | -148.24 | -149.29 | -150.61 | -149.77 | -139.78 | -138.00 | -137.30 |
| Synch Loss Flux Density | dBW/m ² | -166.22 | -166.58 | -166.51 | -167.03 | -165.65 | -165.32 | -166.37 | -167.69 | -166.85 | -156.86 | -155.08 | -154.38 |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -177.30 | -177.65 | -177.58 | -178.10 | -176.73 | -176.39 | -179.57 | -180.90 | -180.05 | -181.51 | -179.74 | -179.04 |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 |
| Delta Relative To Spec. | dB | 7.3 | 7.7 | 7.6 | 8.1 | 6.7 | 6.4 | 9.6 | 10.9 | 10.1 | 11.5 | 9.7 | 9.0 |

TABLE 17: KU-BAND CARRIERS

| Carrier | | IDRX7 | IDRX8 | IDRX9 | IDR107 | IDR108 | IDR109 | IBS-7 | IBS-8 | IBS-9 | 8PSK-7 | 8PSK-8 | 8PSK-9 |
|---------------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Modulation | | QPSK |
| Coding | | FEC 3/4 | FEC 1/2 | FEC 1/2 | FEC 1/2 | FEC 2/3 | FEC 2/3 | FEC 2/3 |
| Information Rate | kbit/s | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 2048 | 2048 | 2048 |
| Transmission Rate | kbit/s | 85 | 85 | 85 | 85 | 85 | 85 | 140 | 140 | 140 | 3504 | 3504 | 3504 |
| Noise Bandwidth | kHz | 51.2 | 51.2 | 51.2 | 51.2 | 51.2 | 51.2 | 83.7 | 83.7 | 83.7 | 1168 | 1168 | 1168 |
| Clear Sky C/N+I | dB | 10.5 | 10.2 | 10.3 | 10.2 | 11.3 | 11.5 | 5.8 | 5.5 | 5.8 | 12.0 | 12.7 | 13.2 |
| Uplink Frequency | GHz | 6.0 | 6.0 | 6.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| Uplink APFD | dBW/(m ² /4kHz) | N/A | N/A | N/A | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 |
| Uplink e.i.r.p. | dBW | 49.2 | 49.1 | 49.2 | 44.9 | 46.6 | 46.7 | 40.1 | 39.9 | 40.3 | 60.5 | 61.8 | 62.5 |
| Uplink Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Atmospheric Absorption | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Transmit Elevation Angle | degrees | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 |
| Uplink Path Length | km | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | dB | N/A | N/A | N/A | 34.4 | 35.8 | 36.0 | 27.5 | 26.9 | 27.4 | 36.5 | 37.4 | 38.2 |
| Resulting Clear Sky C/N+I | dB | 11 | 10 | 10 | 10.2 | 11.3 | 11.5 | 5.8 | 5.5 | 5.8 | 12.0 | 12.7 | 13.2 |
| Downlink Frequency | GHz | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 |
| Receive Gain of 1m ² | dBi | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 |
| Receive Antenna Diam. | m | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| Receive Antenna Gain | dBi | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 |
| Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Receiver Elevation Angle | degrees | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 |
| Downlink Path Length | km | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37077 | 38625 | 38293 | 37074 | 38625 | 38293 |
| Downlink Path Loss | dB | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 |
| Atmospheric Absorption | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 4.1 | 4.1 | 4.1 | 8.4 | 8.4 | 8.4 |
| Synch Loss C/I | dB | 6.4 | 6.6 | 6.5 | 6.6 | 6.2 | 6.1 | 9.0 | 9.7 | 9.0 | 10.9 | 10.4 | 10.1 |
| Downlink e.i.r.p. | dBW | 5.5 | 5.1 | 5.3 | 4.2 | 5.5 | 5.7 | 7.3 | 7.7 | 7.3 | 19.7 | 20.6 | 21.3 |
| Power at Antenna Output | dBW | -142.73 | -143.49 | -143.21 | -144.03 | -143.09 | -142.81 | -140.93 | -140.89 | -141.21 | -128.53 | -127.99 | -127.21 |
| Synch Loss Interfering Power | dBW | -149.17 | -150.04 | -149.73 | -150.59 | -149.24 | -148.91 | -149.93 | -150.58 | -150.21 | -139.40 | -138.38 | -137.34 |
| Synch Loss Flux Density | dBW/m ² | -164.31 | -165.19 | -164.87 | -165.73 | -164.38 | -164.05 | -165.07 | -165.72 | -165.35 | -154.54 | -153.53 | -152.48 |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -175.38 | -176.26 | -175.94 | -176.80 | -175.46 | -175.12 | -178.28 | -178.93 | -178.56 | -179.19 | -178.18 | -177.14 |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 |
| Delta Relative To Spec. | dB | 5.4 | 6.3 | 5.9 | 6.8 | 5.5 | 5.1 | 8.3 | 8.9 | 8.6 | 9.2 | 8.2 | 7.1 |

TABLE 18: KU-BAND CARRIERS

| Carrier | | IDRX4 | IDRX5 | IDRX6 | IDR104 | IDR105 | IDR106 | IBS-4 | IBS-5 | IBS-6 | 8PSK-4 | 8PSK-5 | 8PSK-6 |
|---------------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Modulation | | QPSK |
| Coding | | FEC 3/4 | FEC 1/2 | FEC 1/2 | FEC 1/2 | FEC 2/3 | FEC 2/3 | FEC 2/3 |
| Information Rate | kbit/s | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 2048 | 2048 | 2048 |
| Transmission Rate | kbit/s | 85 | 85 | 85 | 85 | 85 | 85 | 140 | 140 | 140 | 3504 | 3504 | 3504 |
| Noise Bandwidth | kHz | 51.2 | 51.2 | 51.2 | 51.2 | 51.2 | 51.2 | 83.7 | 83.7 | 83.7 | 1168 | 1168 | 1168 |
| Clear Sky C/N+I | dB | 10.5 | 11.0 | 11.0 | 10.5 | 12.0 | 12.0 | 6.2 | 6.3 | 6.4 | 12.0 | 13.0 | 13.5 |
| Uplink Frequency | GHz | 6.0 | 6.0 | 6.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| Uplink APFD | dBW/(m ² /4kHz) | N/A | N/A | N/A | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 |
| Uplink e.i.r.p. | dBW | 56.5 | 57.5 | 57.4 | 53.8 | 55.7 | 55.6 | 47.8 | 49.3 | 49.3 | 68.6 | 70.4 | 70.8 |
| Uplink Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Atmospheric Absorption | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Transmit Elevation Angle | degrees | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 |
| Uplink Path Length | km | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | dB | N/A | N/A | N/A | 43.3 | 44.9 | 44.9 | 35.2 | 36.3 | 36.4 | 44.6 | 46.0 | 46.5 |
| Resulting Clear Sky C/N+I | dB | 11 | 11 | 11 | 10.5 | 12.0 | 12.0 | 6.2 | 6.3 | 6.4 | 12.0 | 13.0 | 13.5 |
| Downlink Frequency | GHz | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 |
| Receive Gain of 1m ² | dBi | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 |
| Receive Antenna Diam. | m | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 |
| Receive Antenna Gain | dBi | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 |
| Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Receiver Elevation Angle | degrees | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 |
| Downlink Path Length | km | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37077 | 38625 | 38293 | 37074 | 38625 | 38293 |
| Downlink Path Loss | dB | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 |
| Atmospheric Absorption | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 4.1 | 4.1 | 4.1 | 8.4 | 8.4 | 8.4 |
| Synch Loss C/I | dB | 6.4 | 6.3 | 6.3 | 6.4 | 6.0 | 6.0 | 8.3 | 8.1 | 8.0 | 10.9 | 10.2 | 10.0 |
| Downlink e.i.r.p. | dBW | 11.9 | 12.6 | 12.6 | 12.1 | 13.6 | 13.5 | 13.2 | 13.3 | 13.3 | 26.9 | 28.2 | 28.6 |
| Power at Antenna Output | dBW | -146.79 | -146.45 | -146.37 | -146.59 | -145.45 | -145.47 | -145.49 | -145.75 | -145.67 | -131.79 | -130.85 | -130.37 |
| Synch Loss Interfering Power | dBW | -153.22 | -152.70 | -152.63 | -153.02 | -151.41 | -151.44 | -153.79 | -153.89 | -153.67 | -142.66 | -141.08 | -140.37 |
| Synch Loss Flux Density | dBW/m ² | -157.91 | -157.39 | -157.31 | -157.71 | -156.10 | -156.12 | -158.48 | -158.58 | -158.35 | -147.35 | -145.77 | -145.05 |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -168.98 | -168.46 | -168.38 | -168.78 | -167.17 | -167.19 | -171.68 | -171.78 | -171.56 | -172.00 | -170.42 | -169.70 |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 |
| Delta Relative To Spec. | DB | -1.0 | -1.5 | -1.6 | -1.2 | -2.8 | -2.8 | 1.7 | 1.8 | 1.6 | 2.0 | 0.4 | -0.3 |

TABLE 19: KU-BAND CARRIERS

| Carrier | | IDRX1 | IDRX2 | IDRX3 | IDR101 | IDR102 | IDR103 | IBS-1 | IBS-2 | IBS-3 | 8PSK-1 | 8PSK-2 | 8PSK-3 |
|---------------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Modulation | | QPSK |
| Coding | | FEC 3/4 | FEC 1/2 | FEC 1/2 | FEC 1/2 | FEC 2/3 | FEC 2/3 | FEC 2/3 |
| Information Rate | kbit/s | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 2048 | 2048 | 2048 |
| Transmission Rate | kbit/s | 85 | 85 | 85 | 85 | 85 | 85 | 140 | 140 | 140 | 3504 | 3504 | 3504 |
| Noise Bandwidth | KHz | 51.2 | 51.2 | 51.2 | 51.2 | 51.2 | 51.2 | 83.7 | 83.7 | 83.7 | 1168 | 1168 | 1168 |
| Clear Sky C/N+I | DB | 10.5 | 11.0 | 11.2 | 10.5 | 12.0 | 12.0 | 6.3 | 6.2 | 6.7 | 12.0 | 13.1 | 13.5 |
| Uplink Frequency | GHz | 6.0 | 6.0 | 6.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| Uplink APFD | DBW/(m ² /4kHz) | N/A | N/A | N/A | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 |
| Uplink e.i.r.p. | DBW | 66.2 | 67.3 | 67.3 | 63.4 | 65.5 | 65.3 | 53.1 | 53.7 | 54.0 | 78.5 | 80.1 | 80.4 |
| Uplink Pointing Loss | DB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Atmospheric Absorption | DB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Transmit Elevation Angle | Degrees | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 |
| Uplink Path Length | Km | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | DB | N/A | N/A | N/A | 52.9 | 54.7 | 54.6 | 40.5 | 40.7 | 41.1 | 54.5 | 55.7 | 56.1 |
| Resulting Clear Sky C/N+I | DB | 11 | 11 | 11 | 10.5 | 12.0 | 12.0 | 6.3 | 6.2 | 6.7 | 12.0 | 13.1 | 13.5 |
| Downlink Frequency | GHz | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 |
| Receive Gain of 1m ² | dBi | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 |
| Receive Antenna Diam. | m | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Receive Antenna Gain | dBi | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 |
| Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Receiver Elevation Angle | degrees | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 | 55.2 | 37.0 | 40.5 |
| Downlink Path Length | km | 37074 | 38625 | 38293 | 37074 | 38625 | 38293 | 37077 | 38625 | 38293 | 37074 | 38625 | 38293 |
| Downlink Path Loss | dB | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 | -204.8 | -205.2 | -205.1 |
| Atmospheric Absorption | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 4.1 | 4.1 | 4.1 | 8.4 | 8.4 | 8.4 |
| Synch Loss C/I | dB | 6.4 | 6.3 | 6.2 | 6.4 | 6.0 | 6.0 | 8.2 | 8.3 | 7.6 | 10.9 | 10.2 | 10.0 |
| Downlink e.i.r.p. | dBW | 18.6 | 19.4 | 19.5 | 18.7 | 20.5 | 20.4 | 17.5 | 17.7 | 18.1 | 33.8 | 35.1 | 35.5 |
| Power at Antenna Output | dBW | -146.11 | -145.67 | -145.49 | -146.01 | -144.57 | -144.59 | -147.21 | -147.37 | -146.89 | -130.91 | -129.97 | -129.49 |
| Synch Loss Interfering Power | dBW | -152.55 | -151.92 | -151.68 | -152.44 | -150.53 | -150.56 | -155.36 | -155.68 | -154.49 | -141.79 | -140.15 | -139.49 |
| Synch Loss Flux Density | dBW/m ² | -151.21 | -150.59 | -150.34 | -151.11 | -149.20 | -149.22 | -154.02 | -154.34 | -153.15 | -140.45 | -138.82 | -138.15 |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -162.28 | -161.66 | -161.41 | -162.18 | -160.27 | -160.29 | -167.23 | -167.55 | -166.36 | -165.10 | -163.47 | -162.80 |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 |
| Delta Relative To Spec. | dB | -7.7 | -8.3 | -8.6 | -7.8 | -9.7 | -9.7 | -2.8 | -2.5 | -3.6 | -4.9 | -6.5 | -7.2 |

TABLE 20: KU-BAND CARRIERS

| Carrier | | A3a | A3b | A3c | B7a | B7b | B7c | C3a | C3b | C3c | STR-1 | STR-2 |
|---------------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Modulation | | QPSK |
| Coding | | FEC 1/2 | FEC 3/4 | FEC 3/4 | FEC 3/4 | FEC 3/4 | FEC 1/2 |
| Information Rate | kbit/s | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 1024 | 128 |
| Transmission Rate | kbit/s | 137 | 137 | 137 | 137 | 137 | 137 | 93 | 93 | 93 | 1456 | 273 |
| Noise Bandwidth | kHz | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 56.0 | 56.0 | 56.0 | 874 | 164 |
| Clear Sky C/N+I | dB | 9.0 | 9.6 | 12.6 | 7.0 | 7.3 | 8.4 | 10.8 | 11.4 | 11.9 | 12.1 | 7.3 |
| Uplink Frequency | GHz | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.1 | 14.2 |
| Uplink APFD | dBW/(m ² /4kHz) | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 |
| Uplink e.i.r.p. | dBW | 45.5 | 46.3 | 48.9 | 43.5 | 43.5 | 44.0 | 46.6 | 45.7 | 46.9 | 48.5 | 38.2 |
| Uplink Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.0 | 0.0 |
| Atmospheric Absorption | dB | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Transmit Elevation Angle | degrees | 18.0 | 19.0 | 31.5 | 18.0 | 18.0 | 18.0 | 20.0 | 20.0 | 20 | 28.0 | 35.0 |
| Uplink Path Length | km | 40620 | 40510 | 39174 | 40620 | 40620 | 40620 | 40399 | 40399 | 40399 | 39537 | 38821 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | dB | 32.5 | 33.4 | 36.3 | 30.5 | 30.5 | 31.0 | 35.4 | 34.5 | 35.7 | 26.1 | 23.2 |
| Resulting Clear Sky C/N+I | dB | 9.1 | 9.6 | 12.6 | 7.0 | 7.3 | 8.4 | 10.8 | 11.4 | 11.9 | 12.2 | 7.4 |
| Downlink Frequency | GHz | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 |
| Receive Gain of 1m ² | dBi | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 |
| Receive Antenna Diam. | m | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 10.0 | 8.0 |
| Receive Antenna Gain | dBi | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 57.6 | 59.5 | 57.6 |
| Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Receiver Elevation Angle | degrees | 19.0 | 27.0 | 47.6 | 18.0 | 25.0 | 40.0 | 31.0 | 33.0 | 47.5 | 19.6 | 16.3 |
| Downlink Path Length | km | 40510 | 39643 | 37666 | 40620 | 39856 | 38339 | 39225 | 39021 | 37674 | 40443 | 40809 |
| Downlink Path Loss | dB | -205.6 | -205.4 | -204.9 | -205.6 | -205.4 | -205.1 | -205.3 | -205.3 | -204.9 | -205.6 | -205.6 |
| Atmospheric Absorption | dB | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 |
| Synch Loss C/N+I | dB | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 5.0 | 5.0 | 5.0 | 5.0 | 4.1 |
| Synch Loss C/I | dB | 5.8 | 5.5 | 4.8 | 7.2 | 6.9 | 6.1 | 6.3 | 6.1 | 6.0 | 5.9 | 6.8 |
| Downlink e.i.r.p. | dBW | 6.8 | 7.1 | 10.2 | 4.6 | 4.7 | 5.2 | 7.9 | 7.0 | 8.2 | 20.6 | 8.2 |
| Power at Antenna Output | dBW | -141.80 | -141.31 | -137.77 | -144.03 | -143.76 | -142.92 | -140.42 | -141.28 | -139.77 | -126.05 | -140.57 |
| Synch Loss Interfering Power | dBW | -147.57 | -146.86 | -142.53 | -151.22 | -150.65 | -149.01 | -146.73 | -147.40 | -145.76 | -131.96 | -147.41 |
| Synch Loss Flux Density | dBW/m ² | -162.71 | -162.00 | -157.67 | -166.36 | -165.79 | -164.16 | -161.87 | -162.54 | -160.90 | -149.04 | -162.55 |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -175.83 | -175.12 | -170.79 | -179.48 | -178.91 | -177.27 | -173.33 | -174.00 | -172.36 | -172.43 | -178.67 |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 |
| Delta Relative To Spec. | dB | 5.8 | 5.1 | 0.8 | 9.5 | 8.9 | 7.3 | 3.3 | 4.0 | 2.4 | 2.4 | 8.7 |

TABLE 21: KU-BAND CARRIERS

| Carrier | | C-4a | C-4b | C-4c | A4-1 | A4-2 | A4-3 | C-6a | C-6b | C-6c | B11a | B11b | B11c |
|---------------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Modulation | | QPSK |
| Coding | | FEC 3/4 | FEC 3/4 | FEC 3/4 | FEC 1/2 | FEC 1/2 | FEC 1/2 | FEC 3/4 | FEC 3/4 | FEC 3/4 | FEC 1/2 | FEC 1/2 | FEC 1/2 |
| Information Rate | kbit/s | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 |
| Transmission Rate | kbit/s | 93 | 93 | 93 | 137 | 137 | 137 | 93 | 93 | 93 | 137 | 137 | 137 |
| Noise Bandwidth | kHz | 56.0 | 56.0 | 56.0 | 82.0 | 82.0 | 82.0 | 56.0 | 56.0 | 56.0 | 82.0 | 82.0 | 82.0 |
| Clear Sky C/N+I | dB | 11.3 | 11.8 | 12.6 | 7.0 | 8.9 | 11.9 | 13.2 | 13.2 | 14.3 | 8.6 | 8.6 | 9.5 |
| Uplink Frequency | GHz | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.1 | 14.2 | 14.2 |
| Uplink APFD | dBW/(m ² /4kHz) | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 |
| Uplink e.i.r.p. | dBW | 53.5 | 54.1 | 55.0 | 52.3 | 53.7 | 58.2 | 55.647 | 55.647 | 56.621 | 51.7 | 53.3 | 54.1 |
| Uplink Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Atmospheric Absorption | dB | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Transmit Elevation Angle | degrees | 30.0 | 21.0 | 40.0 | 31.2 | 31.2 | 31.2 | 30.0 | 32.0 | 32 | 25.0 | 25.0 | 30.0 |
| Uplink Path Length | km | 39328 | 40290 | 38339 | 39210 | 39210 | 39210 | 39328 | 39123 | 39123 | 39856 | 39856 | 39328 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | dB | 42.6 | 43.0 | 44.3 | 39.7 | 41.1 | 45.6 | 44.7 | 44.7 | 45.7 | 39.0 | 40.6 | 41.5 |
| Resulting Clear Sky C/N+I | dB | 11.3 | 11.8 | 12.6 | 7.0 | 8.9 | 11.9 | 13.2 | 13.2 | 14.3 | 8.6 | 8.6 | 9.5 |
| Downlink Frequency | GHz | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 |
| Receive Gain of 1m ² | dBi | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 |
| Receive Antenna Diam. | m | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 |
| Receive Antenna Gain | dBi | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 | 47.1 |
| Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Receiver Elevation Angle | degrees | 31.2 | 33.8 | 47.6 | 35.0 | 35.0 | 50.0 | 25.0 | 33.8 | 47.6 | 20.0 | 20.0 | 40.0 |
| Downlink Path Length | km | 39210 | 38946 | 37669 | 38821 | 38821 | 37470 | 39856 | 38946 | 37669 | 40399 | 40399 | 38339 |
| Downlink Path Loss | dB | -205.3 | -205.2 | -204.9 | -205.2 | -205.2 | -204.9 | -205.4 | -205.2 | -204.9 | -205.6 | -205.6 | -205.1 |
| Atmospheric Absorption | dB | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 4.1 | 4.1 | 4.1 | 5.0 | 5.0 | 5.0 | 4.1 | 4.1 | 4.1 |
| Synch Loss C/I | dB | 6.2 | 6.0 | 5.8 | 7.2 | 5.8 | 4.9 | 5.7 | 5.7 | 5.5 | 6.0 | 6.0 | 5.6 |
| Downlink e.i.r.p. | dBW | 13.2 | 14.4 | 15.2 | 12.5 | 14.1 | 17.8 | 16.6 | 16.6 | 17.7 | 12.7 | 13.8 | 14.6 |
| Power at Antenna Output | dBW | -145.58 | -144.32 | -143.23 | -146.19 | -144.59 | -140.58 | -142.32 | -142.12 | -140.73 | -146.34 | -145.24 | -143.98 |
| Synch Loss Interfering Power | dBW | -151.73 | -150.33 | -149.06 | -153.41 | -150.43 | -145.47 | -148.03 | -147.83 | -146.27 | -152.34 | -151.24 | -149.56 |
| Synch Loss Flux Density | dBW/m ² | -156.42 | -155.02 | -153.74 | -158.09 | -155.12 | -150.15 | -152.71 | -152.51 | -150.95 | -157.02 | -155.92 | -154.24 |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -167.88 | -166.48 | -165.20 | -171.21 | -168.24 | -163.27 | -164.18 | -163.97 | -162.42 | -170.14 | -169.04 | -167.36 |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 |
| Delta Relative To Spec. | dB | -2.1 | -3.5 | -4.8 | 1.2 | -1.8 | -6.7 | -5.8 | -6.0 | -7.6 | 0.1 | -1.0 | -2.6 |

TABLE 22: KU-BAND CARRIERS

| Carrier | | A5a | A5b | A5c | B14a | B14b | B14c | A8a | A8b | A8c | A11a | A11b | A11c | DTH-1 | DTH-2 |
|---------------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
| Modulation | | QPSK |
| Coding | | FEC 1/2 | FEC 3/4 | FEC 3/4 |
| Information Rate | kbit/s | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 45000 | 36875 |
| Transmission Rate | kbit/s | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 60000 | 49166.67 |
| Noise Bandwidth | kHz | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 82.0 | 36000 | 29500 |
| Clear Sky C/N+I | dB | 8.9 | 11.9 | 13.3 | 10.1 | 10.1 | 11.2 | 11.9 | 13.4 | 15.2 | 17.9 | 17.8 | 19.3 | 10.5 | 9.5 |
| Uplink Frequency | GHz | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.1 | 14.2 | 14.2 | 14.2 | 14.2 |
| Uplink APFD | dBW/(m ² /4kHz) | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 | -170.0 |
| Uplink e.i.r.p. | dBW | 61.5 | 64.2 | 65.5 | 62.5 | 62.5 | 63.5 | 64.2 | 65.6 | 67.3 | 69.9 | 69.9 | 71.3 | 70.4 | 73.5 |
| Uplink Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Atmospheric Absorption | dB | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Transmit Elevation Angle | degrees | 20.0 | 19.0 | 31.0 | 45.0 | 45.0 | 45.0 | 28.0 | 28.0 | 33.75 | 48.0 | 48.0 | 48.0 | 25.3 | 27.1 |
| Uplink Path Length | km | 40399 | 40510 | 39225 | 37888 | 37888 | 37888 | 39537 | 39537 | 38946 | 37633 | 37633 | 37633 | 39824 | 39632 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | dB | 48.6 | 51.3 | 52.9 | 50.2 | 50.2 | 51.2 | 51.5 | 52.9 | 54.8 | 57.7 | 57.7 | 59.1 | 31.2 | 35.2 |
| Resulting Clear Sky C/N+I | dB | 8.9 | 11.9 | 13.3 | 10.1 | 10.1 | 11.2 | 11.9 | 13.4 | 15.2 | 17.9 | 17.8 | 19.3 | 10.5 | 9.5 |
| Downlink Frequency | GHz | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.1 | 11.0 |
| Receive Gain of 1m ² | dBi | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.4 | 42.3 | 42.3 |
| Receive Antenna Diam. | m | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 0.6 | 0.8 |
| Receive Antenna Gain | dBi | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 41.1 | 35.0 | 37.4 |
| Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Receiver Elevation Angle | degrees | 31.2 | 33.8 | 47.6 | 35.0 | 35.0 | 50.0 | 25.0 | 33.8 | 47.6 | 20.0 | 20.0 | 40.0 | 40.0 | 40.0 |
| Downlink Path Length | km | 39210 | 38946 | 37669 | 38821 | 38821 | 37470 | 39856 | 38946 | 37669 | 40399 | 40399 | 38339 | 38339 | 38339 |
| Downlink Path Loss | dB | -205.3 | -205.2 | -204.9 | -205.2 | -205.2 | -204.9 | -205.4 | -205.2 | -204.9 | -205.6 | -205.6 | -205.1 | -205.0 | -204.9 |
| Atmospheric Absorption | dB | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Synch Loss C/N+I | dB | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 5.0 | 5.0 |
| Synch Loss C/I | dB | 5.9 | 4.9 | 4.7 | 5.4 | 5.4 | 5.1 | 4.9 | 4.6 | 4.5 | 4.3 | 4.3 | 4.2 | 6.4 | 6.9 |
| Downlink e.i.r.p. | dBW | 19.0 | 21.6 | 22.9 | 20.0 | 20.0 | 21.0 | 21.6 | 23.0 | 24.7 | 27.4 | 27.4 | 28.8 | 51.4 | 46.4 |
| Power at Antenna Output | dBW | -145.80 | -143.14 | -141.55 | -144.71 | -144.71 | -143.40 | -143.34 | -141.74 | -139.75 | -137.66 | -137.66 | -135.80 | -119.22 | -121.72 |
| Synch Loss Interfering Power | dBW | -151.66 | -148.03 | -146.21 | -150.08 | -150.08 | -148.45 | -148.23 | -146.39 | -144.20 | -141.94 | -141.95 | -140.04 | -125.65 | -128.62 |
| Synch Loss Flux Density | dBW/m ² | -150.33 | -146.70 | -144.87 | -148.74 | -148.74 | -147.12 | -146.90 | -145.05 | -142.87 | -140.61 | -140.61 | -138.70 | -118.29 | -123.76 |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -163.44 | -159.82 | -157.99 | -161.86 | -161.86 | -160.24 | -160.02 | -158.17 | -155.98 | -153.72 | -153.73 | -151.82 | -157.83 | -162.44 |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 |
| Delta Relative To Spec. | dB | -6.6 | -10.2 | -12.0 | -8.1 | -8.1 | -9.8 | -10.0 | -11.8 | -14.0 | -16.3 | -16.3 | -18.2 | -12.2 | -7.6 |

TABLE 23: KA-BAND CARRIERS

| Carrier | | LD512A1 | LD512B1 | LD512C1 | LD512A2 | LD512B2 | LD512C2 | LD-2MA1 | LD-2MB1 | LD-2MC1 | LD-2MA2 | LD-2MB2 | LD-2MC2 |
|--------------------------|-----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Uplink | | | | | | | | | | | | | |
| Modulation | | QPSK |
| Coding | | FEC 3/4 |
| Information Rate | kbit/s | 512 | 512 | 512 | 512 | 512 | 512 | 2048 | 2048 | 2048 | 2048 | 2048 | 2048 |
| Transmission Rate | kbit/s | 703 | 703 | 703 | 703 | 703 | 703 | 2813 | 2813 | 2813 | 2813 | 2813 | 2813 |
| Noise Bandwidth | kHz | 422 | 422 | 422 | 422 | 422 | 422 | 1688 | 1688 | 1688 | 1688 | 1688 | 1688 |
| Uplink Clear Sky C/N+I | dB | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| Uplink Frequency | GHz | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Uplink e.i.r.p. | dBW | 33.4 | 33.8 | 33.8 | 33.4 | 33.8 | 33.8 | 39.5 | 39.9 | 39.8 | 39.5 | 39.9 | 39.8 |
| Uplink Pointing Loss | dB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Atmospheric Absorption | dB | 0.3 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 |
| Transmit Elevation Angle | degrees | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 |
| Uplink Path Length | km | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Synch Loss C/I | dB | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| Uplink C/I Due To NGSO | dB | -153.6 | -153.6 | -153.5 | -153.6 | -153.6 | -153.5 | -153.5 | -153.5 | -153.6 | -153.5 | -153.5 | -153.6 |
| Uplink APFD | dBW/(m ² /40kHz) | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 |
| Delta Relative To Spec. | dB | -5.4 | -5.4 | -5.5 | -5.4 | -5.4 | -5.5 | -5.5 | -5.5 | -5.4 | -5.5 | -5.5 | -5.4 |

TABLE 23 (CONT): KA-BAND CARRIERS

| | | | | | | | | | | | | | |
|------------------------------|-----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Downlink | | | | | | | | | | | | | |
| Modulation | | QPSK |
| Coding | | FEC 3/4 |
| Information Rate | kbit/s | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 |
| Transmission Rate | kbit/s | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 |
| Noise Bandwidth | kHz | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 |
| Downlink Clear Sky C/N+I | dB | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 |
| Downlink Frequency | GHz | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Receive Gain of 1m2 | dBi | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 |
| Receive Antenna Diam. | m | 0.65 | 0.65 | 0.65 | 1.2 | 1.2 | 1.2 | 0.95 | 0.95 | 0.95 | 1.8 | 1.8 | 1.8 |
| Receive Antenna Gain | dBi | 41.1 | 41.1 | 41.1 | 46.5 | 46.5 | 46.5 | 44.4 | 44.4 | 44.4 | 50.0 | 50.0 | 50.0 |
| Pointing Loss | dB | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Receiver Elevation Angle | degrees | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 |
| Downlink Path Length | km | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 |
| Downlink Path Loss | dB | -209.8 | -210.2 | -210.1 | -209.8 | -210.2 | -210.1 | -209.8 | -210.2 | -210.1 | -209.8 | -210.2 | -210.1 |
| Atmospheric Absorption | dB | 0.4 | 0.6 | 0.5 | 0.4 | 0.6 | 0.5 | 0.3 | 0.5 | 0.4 | 0.3 | 0.5 | 0.4 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Synch Loss C/I | dB | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 |
| Downlink e.i.r.p. | dBW | 54.0 | 55.6 | 55.7 | 48.7 | 50.3 | 50.3 | 50.7 | 52.3 | 52.4 | 45.2 | 46.8 | 46.8 |
| Power at Antenna Output | dBW | -115.12 | -114.07 | -113.80 | -115.09 | -114.04 | -113.88 | -115.02 | -113.97 | -113.71 | -114.97 | -113.92 | -113.76 |
| Synch Loss Interfering Power | dBW | -124.81 | -123.76 | -123.50 | -124.79 | -123.74 | -123.57 | -124.72 | -123.67 | -123.40 | -124.66 | -123.62 | -123.45 |
| Synch Loss Flux Density | dBW/m ² | -118.47 | -117.42 | -117.16 | -123.77 | -122.72 | -122.56 | -121.67 | -120.62 | -120.36 | -127.17 | -126.12 | -125.96 |
| Synch Loss Flux Density/BW | dBW/(m ² /40kHz) | -151.54 | -150.49 | -150.22 | -156.84 | -155.79 | -155.62 | -154.74 | -153.69 | -153.42 | -160.24 | -159.19 | -159.02 |
| 100% EPFD Limit | dBW/(m ² /40kHz) | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 |
| Delta Relative To Spec. | dB | -2.5 | -3.5 | -3.8 | 2.8 | 1.8 | 1.6 | 0.7 | -0.3 | -0.6 | 6.2 | 5.2 | 5.0 |

TABLE 24: KA-BAND CARRIERS

| Carrier | | LD-8MA1 | LD-8MB1 | LD-8MC1 | LD-8MA2 | LD-8MB2 | LD-8MC2 | MDR-A1 | MDR-B1 | MDR-C1 | MDR-A2 | MDR-B2 | MDR-C2 |
|--------------------------|-----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Uplink | | | | | | | | | | | | | |
| Modulation | | QPSK |
| Coding | | FEC 3/4 |
| Information Rate | kbit/s | 8192 | 8192 | 8192 | 8192 | 8192 | 8192 | 32768 | 32768 | 32768 | 32768 | 32768 | 32768 |
| Transmission Rate | kbit/s | 11254 | 11254 | 11254 | 11254 | 11254 | 11254 | 45015 | 45015 | 45015 | 45015 | 45015 | 45015 |
| Noise Bandwidth | kHz | 6752 | 6752 | 6752 | 6752 | 6752 | 6752 | 27009 | 27009 | 27009 | 27009 | 27009 | 27009 |
| Uplink Clear Sky C/N+I | dB | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| Uplink Frequency | GHz | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Uplink e.i.r.p. | dBW | 45.5 | 45.9 | 45.8 | 45.5 | 45.9 | 45.8 | 50.8 | 51.2 | 51.1 | 50.8 | 51.2 | 51.1 |
| Uplink Pointing Loss | dB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Atmospheric Absorption | dB | 0.3 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 |
| Transmit Elevation Angle | degrees | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 |
| Uplink Path Length | km | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Synch Loss C/I | dB | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 |
| Uplink C/I Due To NGSO | dB | -153.5 | -153.5 | -153.6 | -153.5 | -153.5 | -153.6 | -154.9 | -154.9 | -155.0 | -154.9 | -154.9 | -155.0 |
| Uplink APFD | dBW/(m ² /40kHz) | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 |
| Delta Relative To Spec. | dB | -5.5 | -5.5 | -5.4 | -5.5 | -5.5 | -5.4 | -4.1 | -4.1 | -4.0 | -4.1 | -4.1 | -4.0 |

TABLE 24 (CONT): KA-BAND CARRIERS

| Downlink | | | | | | | | | | | | | |
|------------------------------|-----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Modulation | | QPSK |
| Coding | | FEC 3/4 |
| Information Rate | kbit/s | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 | 98304 |
| Transmission Rate | kbit/s | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 | 135044 |
| Noise Bandwidth | kHz | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 | 81026 |
| Downlink Clear Sky C/N+I | dB | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 |
| Downlink Frequency | GHz | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Receive Gain of 1m2 | dBi | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 |
| Receive Antenna Diam. | m | 1.2 | 1.2 | 1.2 | 2.4 | 2.4 | 2.4 | 1.8 | 1.8 | 1.8 | 3.8 | 3.8 | 3.8 |
| Receive Antenna Gain | dBi | 46.5 | 46.5 | 46.5 | 52.5 | 52.5 | 52.5 | 50.0 | 50.0 | 50.0 | 56.5 | 56.5 | 56.5 |
| Pointing Loss | dB | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Receiver Elevation Angle | degrees | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 |
| Downlink Path Length | km | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 |
| Downlink Path Loss | dB | -209.8 | -210.2 | -210.1 | -209.8 | -210.2 | -210.1 | -209.8 | -210.2 | -210.1 | -209.8 | -210.2 | -210.1 |
| Atmospheric Absorption | dB | 0.3 | 0.5 | 0.4 | 0.3 | 0.5 | 0.4 | 0.3 | 0.5 | 0.4 | 0.3 | 0.5 | 0.4 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Synch Loss C/I | dB | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 |
| Downlink e.i.r.p. | dBW | 48.7 | 50.3 | 50.4 | 42.7 | 44.2 | 44.3 | 45.2 | 46.8 | 46.8 | 38.7 | 40.3 | 40.3 |
| Power at Antenna Output | dBW | -114.99 | -113.94 | -113.68 | -114.97 | -114.02 | -113.76 | -114.97 | -113.92 | -113.76 | -114.98 | -113.93 | -113.77 |
| Synch Loss Interfering Power | dBW | -124.69 | -123.64 | -123.37 | -124.67 | -123.72 | -123.45 | -124.66 | -123.62 | -123.45 | -124.67 | -123.63 | -123.46 |
| Synch Loss Flux Density | dBW/m ² | -123.67 | -122.62 | -122.36 | -129.67 | -128.72 | -128.46 | -127.17 | -126.12 | -125.96 | -133.67 | -132.62 | -132.46 |
| Synch Loss Flux Density/BW | dBW/(m ² /40kHz) | -156.74 | -155.69 | -155.42 | -162.74 | -161.79 | -161.52 | -160.24 | -159.19 | -159.02 | -166.74 | -165.69 | -165.52 |
| 100% EPFD Limit | dBW/(m ² /40kHz) | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 |
| Delta Relative To Spec. | dB | 2.7 | 1.7 | 1.4 | 8.7 | 7.8 | 7.5 | 6.2 | 5.2 | 5.0 | 12.7 | 11.7 | 11.5 |

TABLE 25: KA-BAND CARRIERS

| Carrier | | HDR-A1 | HDR-B1 | HDR-C1 | HDR-A2 | HDR-B2 | HDR-C2 |
|---------------------------------|-----------------------------|---------|---------|---------|---------|---------|---------|
| Uplink | | | | | | | |
| Modulation | | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Coding | | FEC 3/4 |
| Information Rate | kbit/s | 155520 | 155520 | 155520 | 155520 | 155520 | 155520 |
| Transmission Rate | kbit/s | 213644 | 213644 | 213644 | 213644 | 213644 | 213644 |
| Noise Bandwidth | kHz | 128186 | 128186 | 128186 | 128186 | 128186 | 128186 |
| Uplink Clear Sky C/N+I | dB | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| Uplink Frequency | GHz | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Uplink e.i.r.p. | dBW | 57.6 | 58.0 | 57.9 | 57.6 | 58.0 | 57.9 |
| Uplink Pointing Loss | dB | 0 | 0 | 0 | 0 | 0 | 0 |
| Atmospheric Absorption | dB | 0.3 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 |
| Transmit Elevation Angle | degrees | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 |
| Uplink Path Length | km | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Synch Loss C/I | dB | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 |
| Uplink C/I Due To NGSO | dB | -154.7 | -154.8 | -154.8 | -154.7 | -154.8 | -154.8 |
| Uplink APFD | dBW/(m ² /40kHz) | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 |
| Delta Relative To Spec. | dB | -4.3 | -4.2 | -4.2 | -4.3 | -4.2 | -4.2 |
| Downlink | | | | | | | |
| Modulation | | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Coding | | FEC 3/4 |
| Information Rate | kbit/s | 155520 | 155520 | 155520 | 155520 | 155520 | 155520 |
| Transmission Rate | kbit/s | 213644 | 213644 | 213644 | 213644 | 213644 | 213644 |
| Noise Bandwidth | kHz | 128186 | 128186 | 128186 | 128186 | 128186 | 128186 |
| Downlink Clear Sky C/N+I | dB | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 |
| Downlink Frequency | GHz | 20 | 20 | 20 | 20 | 20 | 20 |
| Receive Gain of 1m ² | dBi | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 |
| Receive Antenna Diam. | m | 3.5 | 3.5 | 3.5 | 5.0 | 5.0 | 5.0 |
| Receive Antenna Gain | dBi | 55.8 | 55.8 | 55.8 | 58.9 | 58.9 | 58.9 |
| Pointing Loss | dB | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Receiver Elevation Angle | degrees | 55.0 | 37.0 | 40.0 | 55.0 | 37.0 | 40.0 |
| Downlink Path Length | km | 37091 | 38625 | 38339 | 37091 | 38625 | 38339 |
| Downlink Path Loss | dB | -209.8 | -210.2 | -210.1 | -209.8 | -210.2 | -210.1 |
| Atmospheric Absorption | dB | 0.3 | 0.5 | 0.4 | 0.3 | 0.5 | 0.4 |
| Synch Loss C/N+I | dB | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Synch Loss C/I | dB | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 |
| Downlink e.i.r.p. | dBW | 41.4 | 43.0 | 43.0 | 38.3 | 39.9 | 39.9 |
| Power at Antenna Output | dBW | -112.99 | -111.95 | -111.78 | -113.00 | -111.95 | -111.78 |
| Synch Loss Interfering Power | dBW | -122.69 | -121.64 | -121.48 | -122.69 | -121.64 | -121.48 |
| Synch Loss Flux Density | dBW/m ² | -130.97 | -129.92 | -129.76 | -134.07 | -133.02 | -132.86 |
| Synch Loss Flux Density/BW | dBW/(m ² /40kHz) | -166.03 | -164.98 | -164.82 | -169.13 | -168.08 | -167.92 |
| 100% EPFD Limit | dBW/(m ² /40kHz) | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 |
| Delta Relative To Spec. | dB | 12.0 | 11.0 | 10.8 | 15.1 | 14.1 | 13.9 |

TABLE 26: KA-BAND CARRIERS

| Carrier | | KA-01 | KA-02 | KA-03 | KA-04 | KA-05 | KA-06 | KA-07 | KA-08 | KA-09 | KA-10 |
|--------------------------|-----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Uplink | | | | | | | | | | | |
| Modulation | | QPSK |
| Coding | | FEC 1/2 |
| Information Rate | kbit/s | 128 | 128 | 128 | 128 | 128 | 150000 | 150000 | 150000 | 150000 | 150000 |
| Transmission Rate | kbit/s | 294 | 294 | 294 | 294 | 294 | 344444 | 344444 | 344444 | 344444 | 344444 |
| Noise Bandwidth | KHz | 176 | 176 | 176 | 176 | 176 | 206667 | 206667 | 206667 | 206667 | 206667 |
| Uplink Clear Sky C/N+I | dB | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 |
| Uplink Frequency | GHz | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Uplink e.i.r.p. | dBW | 29.9 | 29.9 | 29.9 | 29.9 | 29.9 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| Uplink Pointing Loss | dB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Atmospheric Absorption | dB | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Transmit Elevation Angle | degrees | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Uplink Path Length | km | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Synch Loss C/N+I | dB | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 |
| Synch Loss C/I | dB | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 |
| Uplink C/I Due To NGSO | dB | -152.0 | -152.0 | -152.0 | -152.0 | -152.0 | -152.6 | -152.6 | -152.6 | -152.6 | -152.6 |
| Uplink APFD | dBW/(m ² /40kHz) | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 |
| Delta Relative To Spec. | dB | -7.0 | -7.0 | -7.0 | -7.0 | -7.0 | -6.4 | -6.4 | -6.4 | -6.4 | -6.4 |

TABLE 26 (CONT): KA-BAND CARRIERS

| | | | | | | | | | | | |
|---------------------------------|-----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Downlink | | | | | | | | | | | |
| Modulation | | QPSK |
| Coding | | FEC 1/2 |
| Information Rate | kbit/s | 110000 | 110000 | 110000 | 110000 | 110000 | 200000 | 200000 | 200000 | 200000 | 200000 |
| Transmission Rate | kbit/s | 253208 | 253208 | 253208 | 253208 | 253208 | 460377 | 460377 | 460377 | 460377 | 460377 |
| Noise Bandwidth | kHz | 151925 | 151925 | 151925 | 151925 | 151925 | 276226 | 276226 | 276226 | 276226 | 276226 |
| Downlink Clear Sky C/N+I | dB | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 |
| Downlink Frequency | GHz | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Receive Gain of 1m ² | dBi | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 |
| Receive Antenna Diam. | m | 0.66 | 1.0 | 1.2 | 1.8 | 2.5 | 3.5 | 3.8 | 4.2 | 4.6 | 5.0 |
| Receive Antenna Gain | dBi | 41.3 | 44.9 | 46.5 | 50.0 | 52.8 | 55.8 | 56.5 | 57.3 | 58.1 | 58.9 |
| Pointing Loss | dB | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Receiver Elevation Angle | degrees | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Downlink Path Length | km | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 | 39328 |
| Downlink Path Loss | dB | -210.4 | -210.4 | -210.4 | -210.4 | -210.4 | -210.4 | -210.4 | -210.4 | -210.4 | -210.4 |
| Atmospheric Absorption | dB | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Synch Loss C/N+I | dB | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 |
| Synch Loss C/I | dB | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 |
| Downlink e.i.r.p. | dBW | 58.2 | 54.6 | 53.0 | 49.5 | 46.7 | 46.3 | 45.6 | 44.7 | 43.9 | 43.2 |
| Power at Antenna Output | dBW | -111.29 | -111.28 | -111.30 | -111.28 | -111.23 | -108.70 | -108.69 | -108.72 | -108.73 | -108.70 |
| Synch Loss Interfering Power | dBW | -117.47 | -117.46 | -117.48 | -117.46 | -117.40 | -114.88 | -114.87 | -114.90 | -114.91 | -114.88 |
| Synch Loss Flux Density | dBW/m ² | -111.26 | -114.86 | -116.46 | -119.96 | -122.76 | -123.16 | -123.86 | -124.76 | -125.56 | -126.26 |
| Synch Loss Flux Density/BW | dBW/(m ² /40kHz) | -147.06 | -150.66 | -152.26 | -155.76 | -158.56 | -161.56 | -162.26 | -163.16 | -163.96 | -164.66 |
| 100% EPFD Limit | dBW/(m ² /40kHz) | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 |
| Delta Relative To Spec. | dB | -6.9 | -3.3 | -1.7 | 1.8 | 4.6 | 7.6 | 8.3 | 9.2 | 10.0 | 10.7 |

TABLE 27: KA-BAND CARRIERS

| Carrier | | KA-01 | KA-02 | KA-03 | KA-04 | KA-05 |
|---------------------------------|-----------------------------|---------|---------|---------|---------|---------|
| Modulation | | QPSK | QPSK | QPSK | QPSK | QPSK |
| Coding | | FEC 1/2 |
| Information Rate | Kbit/s | 2048 | 2048 | 76484 | 76484 | 38242 |
| Transmission Rate | kbit/s | 4463 | 4463 | 166667 | 166667 | 83333 |
| Noise Bandwidth | kHz | 2678 | 2678 | 100000 | 100000 | 50000 |
| Clear Sky C/N+I | dB | 9.2 | 9.2 | 10.8 | 10.2 | 9.9 |
| Uplink Frequency | GHz | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Uplink APFD | dBW/(m ² /40kHz) | -159.0 | -159.0 | -159.0 | -159.0 | -159.0 |
| Uplink e.i.r.p. | dBW | 47.3 | 46.0 | 74.0 | 74.0 | 74.0 |
| Uplink Pointing Loss | dB | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Atmospheric Absorption | dB | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Transmit Elevation Angle | degrees | 28.0 | 24.3 | 20.0 | 21.0 | 21.5 |
| Uplink Path Length | km | 39537 | 39931 | 40399 | 40290 | 40235 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | dB | 18.7 | 17.3 | 29.5 | 29.5 | 32.5 |
| Resulting Clear Sky C/N+I | dB | 9.7 | 9.9 | 10.9 | 10.3 | 9.9 |
| Downlink Frequency | GHz | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Receive Gain of 1m ² | dBi | 47.5 | 47.5 | 47.5 | 47.5 | 47.5 |
| Receive Antenna Diam. | m | 4.5 | 3.5 | 1.8 | 1.2 | 0.8 |
| Receive Antenna Gain | dBi | 57.9 | 55.8 | 50.0 | 46.5 | 42.9 |
| Pointing Loss | dB | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Receiver Elevation Angle | degrees | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Downlink Path Length | km | 37470 | 37470 | 37470 | 37470 | 37470 |
| Downlink Path Loss | dB | -209.9 | -209.9 | -209.9 | -209.9 | -209.9 |
| Atmospheric Absorption | dB | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Synch Loss C/N+I | dB | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 |
| Synch Loss C/I | dB | 5.5 | 5.4 | 5.1 | 5.3 | 5.4 |
| Downlink e.i.r.p. | dBW | 27.5 | 33.8 | 53.0 | 55.0 | 55.0 |
| Power at Antenna Output | dBW | -124.90 | -120.78 | -107.36 | -108.88 | -112.40 |
| Synch Loss Interfering Power | dBW | -130.39 | -126.20 | -112.49 | -114.19 | -117.82 |
| Synch Loss Flux Density | dBW/m ² | -140.86 | -134.48 | -114.99 | -113.17 | -113.28 |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -159.12 | -152.74 | -148.97 | -147.15 | -144.25 |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -154.00 | -154.00 | -154.00 | -154.00 | -154.00 |
| Delta Relative To Spec. | dB | 5.1 | -1.3 | -5.0 | -6.8 | -9.7 |

TABLE 28: BSS CARRIERS

| Carrier | | INAE33 | INDAK310 | INQUE310 | SAS310 | IEAU1377 | INT1D33 | INTSA33 | INTME33 | INJA157 | INT3D33 | IMEX310 | IBIN1377 | MCSA310 | 12SE1377 |
|---------------------------------|----------------------------|---------|----------|----------|---------|----------|---------|---------|---------|---------|---------|---------|----------|---------|----------|
| Modulation | | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| Coding | | FEC 1/2 | FEC 3/4 | FEC 3/4 | FEC 3/4 | FEC 1/2 | FEC 3/4 | FEC 3/4 | FEC 3/4 | FEC 1/2 | FEC 3/4 | FEC 3/4 | FEC 1/2 | FEC 3/4 | |
| Information Rate | kbit/s | 25354 | 27659 | 27659 | 27659 | 25354 | 25354 | 25354 | 25354 | 20744 | 25354 | 27659 | 25354 | 25354 | 25354 |
| Transmission Rate | kbit/s | 27500 | 40000 | 40000 | 40000 | 27500 | 27500 | 27500 | 27500 | 22500 | 27500 | 40000 | 27500 | 27500 | 27500 |
| Noise Bandwidth | kHz | 33000 | 24000.0 | 24000.0 | 24000.0 | 33000.0 | 33000.0 | 33000.0 | 33000.0 | 27000.0 | 33000.0 | 24000.0 | 33000.0 | 33000.0 | 33000.0 |
| Clear Sky C/N+I | dB | 13.6 | 14.9 | 15.2 | 15.0 | 13.4 | 13.4 | 13.6 | 13.6 | 16.7 | 13.4 | 17.9 | 15.7 | 16.9 | 15.9 |
| Uplink Frequency | GHz | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 |
| Uplink APFD | dBW/(m ² /4kHz) | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 |
| Uplink e.i.r.p. | dBW | 85.0 | 87.4 | 87.4 | 87.4 | 85.0 | 85.0 | 85.0 | 85.0 | 85.0 | 85.0 | 87.4 | 85.0 | 87.4 | 85.0 |
| Uplink Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Atmospheric Absorption | dB | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Transmit Elevation Angle | degrees | 54.2 | 11.5 | 24.0 | 32.5 | 49.3 | 35.5 | 68.1 | 49.2 | 37.9 | 37.0 | 29.7 | 21.6 | 76.6 | 71.4 |
| Uplink Path Length | km | 37149 | 41346 | 39964 | 39072 | 37526 | 38772 | 36306 | 37534 | 38538 | 38625 | 39359 | 40224 | 35979 | 36161 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | dB | 39.5 | 42.4 | 42.7 | 42.9 | 39.4 | 39.2 | 39.7 | 39.4 | 40.1 | 39.2 | 42.8 | 38.8 | 42.2 | 39.8 |
| Resulting Clear Sky C/N+I | dB | 13.6 | 14.9 | 15.2 | 15.0 | 13.4 | 13.4 | 13.6 | 13.6 | 16.7 | 13.4 | 17.9 | 15.7 | 16.9 | 15.9 |
| Downlink Frequency | GHz | 12.0 | 12.0 | 12.1 | 12.1 | 12.1 | 12.1 | 12.1 | 12.1 | 12.1 | 12.1 | 12.1 | 12.1 | 12.1 | 12.0 |
| Receive Gain of 1m ² | dBi | 43.0 | 43.0 | 43.1 | 43.1 | 43.1 | 43.1 | 43.1 | 43.1 | 43.1 | 43.1 | 43.1 | 43.1 | 43.3 | 43.0 |
| Receive Antenna Diam. | m | 0.6 | 1.0 | 1.0 | 1.0 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1.0 | 0.6 | 1.0 | 0.6 |
| Receive Antenna Gain | dBi | 35.7 | 40.1 | 40.2 | 40.2 | 35.7 | 35.7 | 35.7 | 35.7 | 35.7 | 35.7 | 40.2 | 35.7 | 40.4 | 35.7 |
| Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Receiver Elevation Angle | degrees | 54.2 | 11.5 | 24.0 | 32.5 | 49.3 | 35.5 | 68.1 | 49.2 | 37.9 | 37.0 | 29.7 | 21.6 | 76.6 | 71.4 |
| Downlink Path Length | km | 37149 | 41346 | 39964 | 39072 | 37526 | 38772 | 36306 | 37534 | 38538 | 38625 | 39359 | 40224 | 35979 | 36161 |
| Downlink Path Loss | dB | -205.4 | -206.4 | -206.1 | -205.9 | -205.6 | -205.9 | -205.3 | -205.6 | -205.8 | -205.8 | -206.0 | -206.2 | -205.4 | -205.2 |
| Atmospheric Absorption | dB | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Synch Loss C/N+I | dB | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 |
| Synch Loss C/I | dB | 6.7 | 6.5 | 6.4 | 6.5 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.2 | 6.4 | 6.4 |
| Downlink e.i.r.p. | dBW | 52.0 | 52.0 | 52.0 | 52.0 | 52.0 | 52.0 | 52.0 | 52.0 | 55.0 | 52.0 | 55.0 | 55.0 | 55.0 | 55.0 |
| Power at Antenna Output | dBW | -118.55 | -115.04 | -114.75 | -114.55 | -118.64 | -118.92 | -118.35 | -118.64 | -115.87 | -118.89 | -111.61 | -116.24 | -110.83 | -115.31 |
| Synch Loss Interfering Power | dBW | -125.25 | -121.52 | -121.19 | -121.02 | -125.38 | -125.67 | -125.05 | -125.34 | -122.14 | -125.63 | -117.80 | -122.62 | -117.09 | -121.67 |
| Synch Loss Flux Density | dBW/m ² | -117.90 | -118.60 | -118.27 | -118.10 | -118.03 | -118.31 | -117.70 | -117.99 | -114.79 | -118.28 | -114.88 | -115.26 | -114.17 | -114.31 |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -157.06 | -156.39 | -156.05 | -155.88 | -157.19 | -157.47 | -156.86 | -157.15 | -153.08 | -157.44 | -152.66 | -154.42 | -153.34 | -153.48 |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 |
| Delta Relative To Spec. | dB | -12.9 | -13.6 | -14.0 | -14.1 | -12.8 | -12.5 | -13.1 | -12.8 | -16.9 | -12.6 | -17.3 | -15.6 | -16.7 | -16.5 |

TABLE 29: BSS CARRIERS

| Carrier | | 805-1A | 805-2A | 805-3 | 805-4 | INTSI-3 | INTSI-4 | INTCN-3 | INTCN-4 |
|---------------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| Modulation | | QPSK |
| Coding | | FEC 3/4 | FEC 1/2 |
| Information Rate | kbit/s | 6600 | 6600 | 33999 | 22999 | 33999 | 22999 | 33999 | 22999 |
| Transmission Rate | kbit/s | 9545 | 7158 | 49168 | 24946 | 49168 | 24946 | 49168 | 24946 |
| Noise Bandwidth | kHz | 5700 | 8600 | 29500 | 29900 | 29500 | 29900 | 29500 | 29900 |
| Clear Sky C/N+I | dB | 13.2 | 10.2 | 12.6 | 10.2 | 9.0 | 6.5 | 10.8 | 7.6 |
| Uplink Frequency | GHz | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 |
| Uplink APFD | dBW/(m ² /4kHz) | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 | -163.0 |
| Uplink e.i.r.p. | dBW | 61.2 | 88.2 | 69.0 | 88.2 | 69.0 | 78.2 | 68.5 | 74.2 |
| Uplink Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Atmospheric Absorption | dB | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Transmit Elevation Angle | degrees | 28.0 | 28.0 | 28.0 | 28.0 | 35.4 | 25.8 | 48.7 | 61.7 |
| Uplink Path Length | km | 39537 | 39537 | 39537 | 39537 | 38782 | 39770 | 37575 | 36650 |
| Number of NGSO Systems | # | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Uplink C/I Due To NGSO | dB | 22.8 | 48.0 | 23.5 | 42.6 | 23.6 | 32.6 | 23.4 | 29.3 |
| Resulting Clear Sky C/N+I | dB | 13.7 | 10.2 | 13.0 | 10.2 | 9.2 | 6.6 | 11.0 | 7.6 |
| Downlink Frequency | GHz | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 |
| Receive Gain of 1m ² | dBi | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 |
| Receive Antenna Diam. | m | 0.99 | 0.53 | 0.99 | 0.61 | 0.99 | 0.61 | 0.99 | 0.61 |
| Receive Antenna Gain | dBi | 40.3 | 35.0 | 40.3 | 36.1 | 40.3 | 36.1 | 40.3 | 36.1 |
| Pointing Loss | dB | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Receiver Elevation Angle | degrees | 68.8 | 69.2 | 76.1 | 74.6 | 36.9 | 57.8 | 26.2 | 25.7 |
| Downlink Path Length | km | 36274 | 36255 | 35994 | 36042 | 38635 | 36897 | 39728 | 39781 |
| Downlink Path Loss | dB | -205.6 | -205.6 | -205.5 | -205.5 | -206.1 | -205.7 | -206.4 | -206.4 |

| Atmospheric Absorption | dB | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
|------------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|-----|
| Synch Loss C/N+I | dB | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 |
| Synch Loss C/I | dB | 6.7 | 7.9 | 6.9 | 7.9 | 8.7 | 14.5 | 7.5 | 10.8 | |
| Downlink e.i.r.p. | dBW | 45.5 | 46.8 | 51.0 | 51.0 | 46.5 | 47.3 | 49.0 | 49.0 | |
| Power at Antenna Output | dBW | -120.53 | -124.61 | -114.96 | -119.17 | -120.07 | -123.07 | -117.82 | -122.03 | |
| Synch Loss Interfering Power | dBW | -127.22 | -132.55 | -121.81 | -127.10 | -128.73 | -137.54 | -125.32 | -132.85 | |
| Synch Loss Flux Density | dBW/m ² | -124.18 | -124.11 | -118.77 | -119.86 | -125.69 | -130.30 | -122.28 | -125.60 | |
| Synch Loss Flux Density/BW | dBW/(m ² /4kHz) | -155.72 | -157.44 | -157.45 | -158.59 | -164.36 | -169.03 | -160.96 | -164.34 | |
| 100% EPFD Limit | dBW/(m ² /4kHz) | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | -170.00 | |
| Delta Relative To Spec. | dB | -14.3 | -12.6 | -12.6 | -11.4 | -5.6 | -1.0 | -9.0 | -5.7 | |

FIGURE 1

TEST SET UP FOR LOSS OF SYNCH MEASUREMENTS

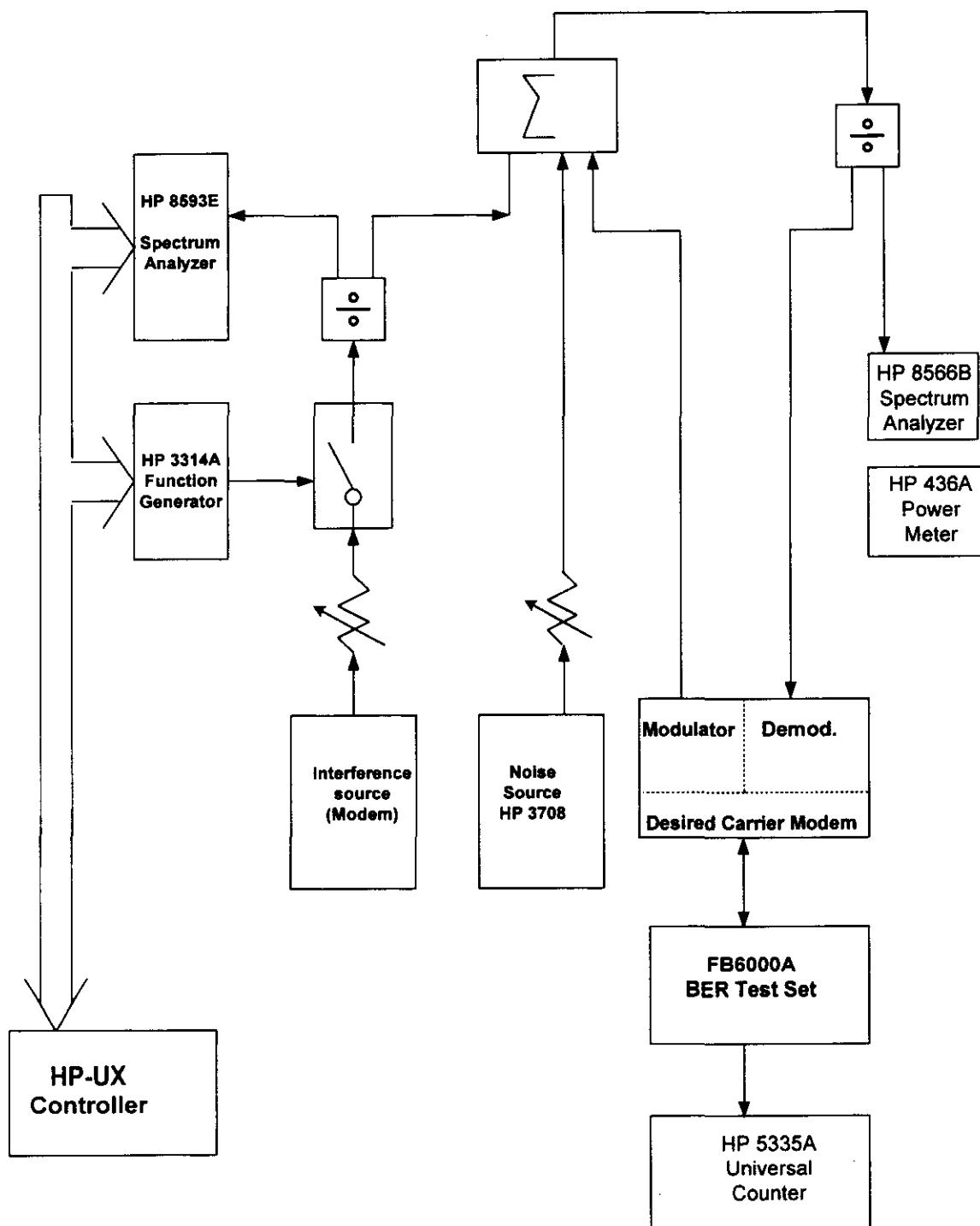


FIGURE 2

TEST SET UP FOR MPEG-2 BLOCK ERRORS

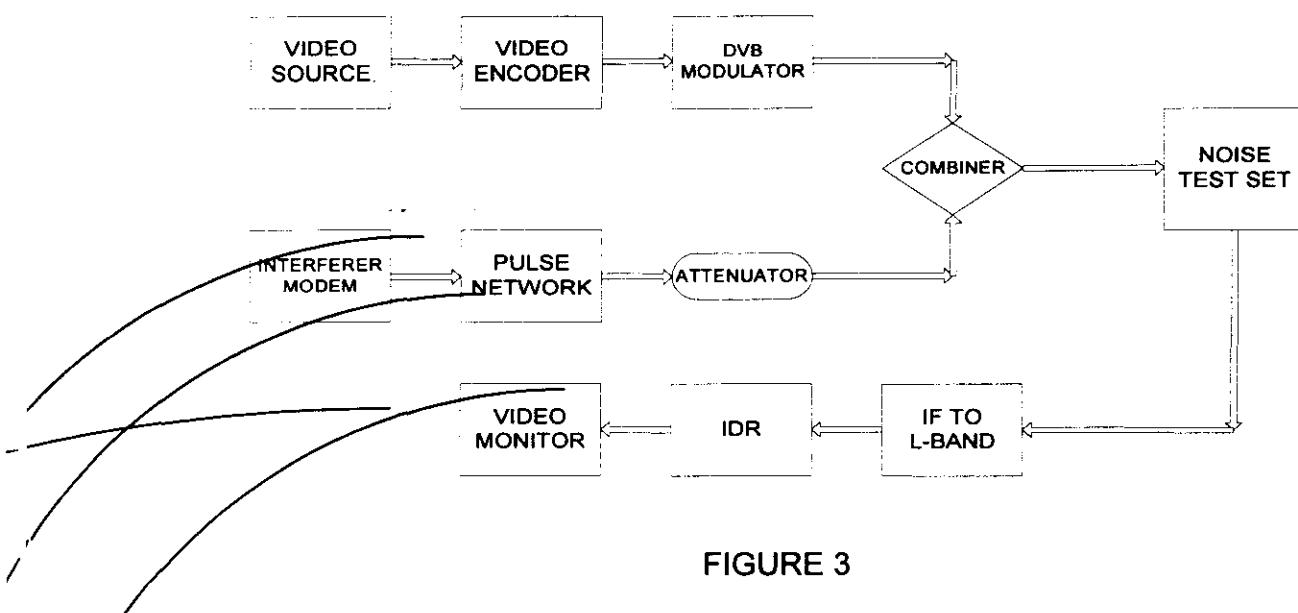


FIGURE 3

NGSO TRAJECTORY

